National Transportation Safety Board

Investigating and Managing Fatigue in Aviation: Lessons Learned

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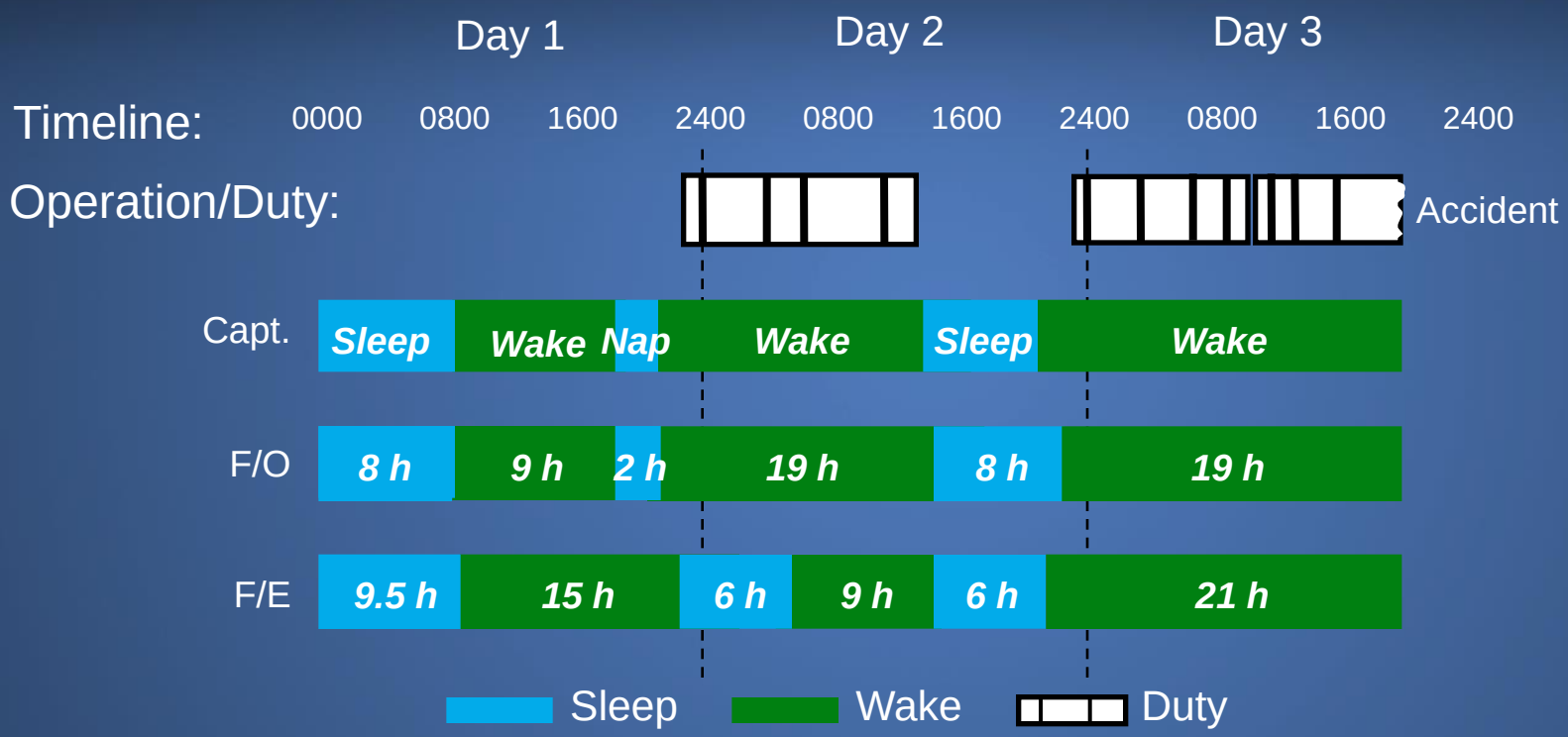
Board Member

Bombardier Safety Standdown
October 7, 2014

Examining Fatigue Factors in an Incident/Accident Investigation or Planned Operation

Slides: ntsb.gov: Board Members

Crew /Trip History

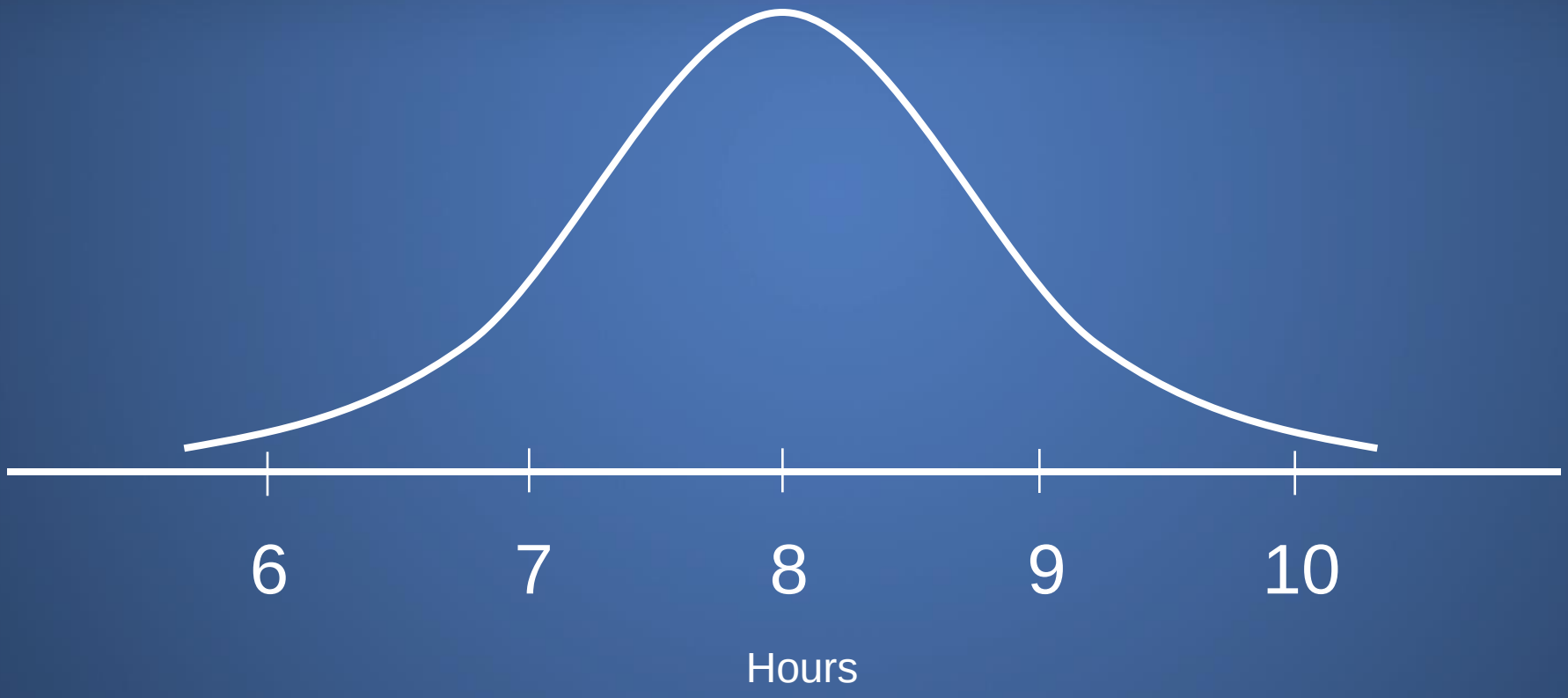


Off Duty (sleep opportunity:sleep)

Fatigue Factors +: Summary

- sleep (loss: acute/cumulative)
  - acute: X hrs
  - cumulative: Y hrs
- circadian/time of day
  - WOCL/time zones/variability/etc.
- continuous hours awake: Z hrs
- sleep disorders: known/treatment/unknown
- other considerations: list

Sleep Requirement



Fatigue Factors +

- Sleep loss
  - acute sleep loss
  - cumulative sleep debt

- Acute sleep loss
  - total sleep in previous 24 hrs
  - note # of sleep periods, timing, etc.

Cumulative Sleep Debt

Sleep Need – Actual Sleep = Sleep Debt

Sleep debt grows cumulatively over time

Fatigue Factors +

- Sleep loss
  - acute sleep loss
  - cumulative sleep debt
- Cumulative sleep debt
  - identify two consecutive night recovery opportunity
  - sleep need — sleep loss = sleep debt

Sleep Loss and Alcohol: Performance Equivalents

Sleep loss (hrs)	12oz Beers	BrEC%
2	2 - 3	.045%
4	5 - 6	.095%
6	7 - 8	.102%
8	10 - 11	.190%

Roehrs et al. Sleep, Vol. 26, No. 8, 2003

Fatigue Factors +

- Circadian/time of day
  - critical operations during circadian low
  - sleep periods during wake zones
  - variability (duty, start, end times)
  - time zones (home vs local time)

Fatigue Factors +

- Continuous hours of wakefulness
  - time since end of last sleep period
  - duty is a subset of continuous wakefulness

Fatigue Factors +

- Sleep disorders
  - known, diagnosed, treated
  - symptoms, possibilities
  - unknown

Fatigue Factors +

- Other considerations (examples)
  - environment
  - task requirements
  - medical history/medications
  - alertness strategies

Fatigue Factors +: Summary

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Fatigue Factor Analysis

- Number of fatigue factors identified
- Severity of each identified factor
- Other considerations identified
- Unknowns and questions

Fatigue: present/not present

Fatigue Risks

- degraded 20 – 50%+:

  - reaction time
  - memory
  - communication
  - situational awareness
  - judgment
  - attention
  - mood

- increased:

  - irritability
  - apathy
  - attentional lapses
  - microsleeps

Performance Issues

- Identify performance related to accident
- Role: contributory vs. causal
- Behavioral description vs. root cause
- Error chain of events
- Fatigue-related performance decrements

Fatigue Factors in Accident

- Determine if fatigue factors present at the time of the accident affected performance changes that were contributory or causal to the accident

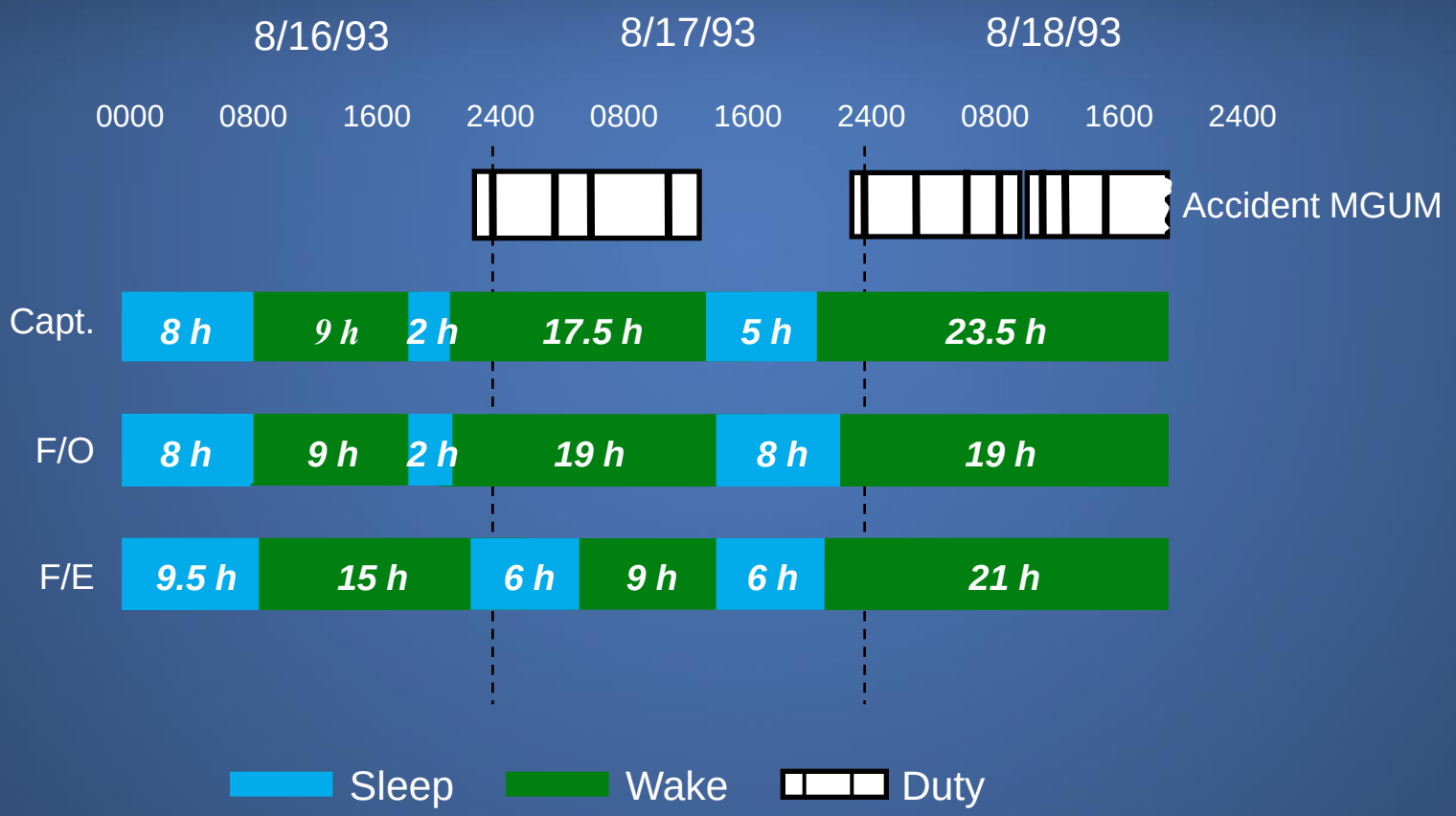
Uncontrolled In-Flight Collision with Terrain
AIA Flight 808, Douglas DC-8-61, N814CK
U.S. NAS, Guantanamo Bay, Cuba, August 18, 1993

First NTSB aviation accident investigation
to cite fatigue as probable cause

- acute sleep loss, sleep debt, circadian disruption

NTSB

Crew Sleep History



NTSB

Observed Performance Effects

- Degraded decision-making
- Visual/cognitive fixation
- Poor communication/coordination
- Slowed reaction time

Uncontrolled In-Flight Collision with Terrain
AIA Flight 808, Douglas DC-8-61, N814CK
U.S. NAS, Guantanamo Bay, Cuba, August 18, 1993

"The National Transportation Safety Board determines that the probable causes of this accident were the impaired judgment, decision making, and flying abilities of the captain and flight crew due to the effects of fatigue…"

Owatonna, MN (July 31, 2008)

8 fatalities

NTSB

Owatonna Crew Fatigue Factors

- acute sleep loss (Capt/FO)
- cumulative sleep debt (FO)
- early start time (Capt/FO)
- excessive sleep need (Capt)
- insomnia (FO)
- self-medicate/prescription sleep med (FO)

Probable Cause/Contributing Factors

"Contributing to the accident were . . . (2) fatigue, which likely impaired both pilots' performance; . . ."

Lubbock, TX (January 27, 2009)

2 injuries

NTSB

Probable Cause/Contributing Factors

"Contributing to the accident were . . .

4) fatigue due to the time of day in which the accident occurred and a cumulative sleep debt, which likely impaired the captain's performance."

Asiana 214 (July 6, 2013)
San Francisco, CA (SFO)

3 fatalities

49 seriously injured

NTSB

Probable Cause

Contributing to the accident were . . .

(5) flight crew fatigue, which likely degraded their performance.

Fatal Aviation Accidents (examples: fatigue cited)

- 8/97 Guam: 228 fatalities
- 6/99 Little Rock AK: 11 fatal
- 10/04 Kirksville MO: 11 fatalities
- 8/06 Lexington KY: 49 fatalities
- 7/08 Owatonna MN: 8 fatalities
- 2/09 Buffalo NY: 49 fatalities
- 6/09 Santa Fe NM: 2 fatalities
- 7/13 San Francisco, CA: 3 fatalities
- 8/13 Birmingham, AL: 2 fatalities

Miami, Oklahoma (June 26, 2009)
Fatigue Factors

- Off work for 3 weeks: day active/night sleep schedule
- 3am to 3pm shift work/drive schedule (since 1997)
- Early bedtime (2 hr phase advance in sleep time)
- Obtained min 3 hrs/max 5 hrs sleep prior to accident
- Subsequently diagnosed with mild sleep apnea

10 fatalities
3 serious injuries
2 minor injuries
5 no injuries

Source: Oklahoma State Police

Probable Cause (fatigue)

"... driver's fatigue, caused by the combined effects of acute sleep loss, circadian disruption associated with his shift work schedule, and mild sleep apnea, which resulted in the driver's failure to react to slowing and stopped traffic ahead by applying the brakes or performing any evasive maneuver to avoid colliding with the traffic queue. . . ."

National Transportation Safety Board

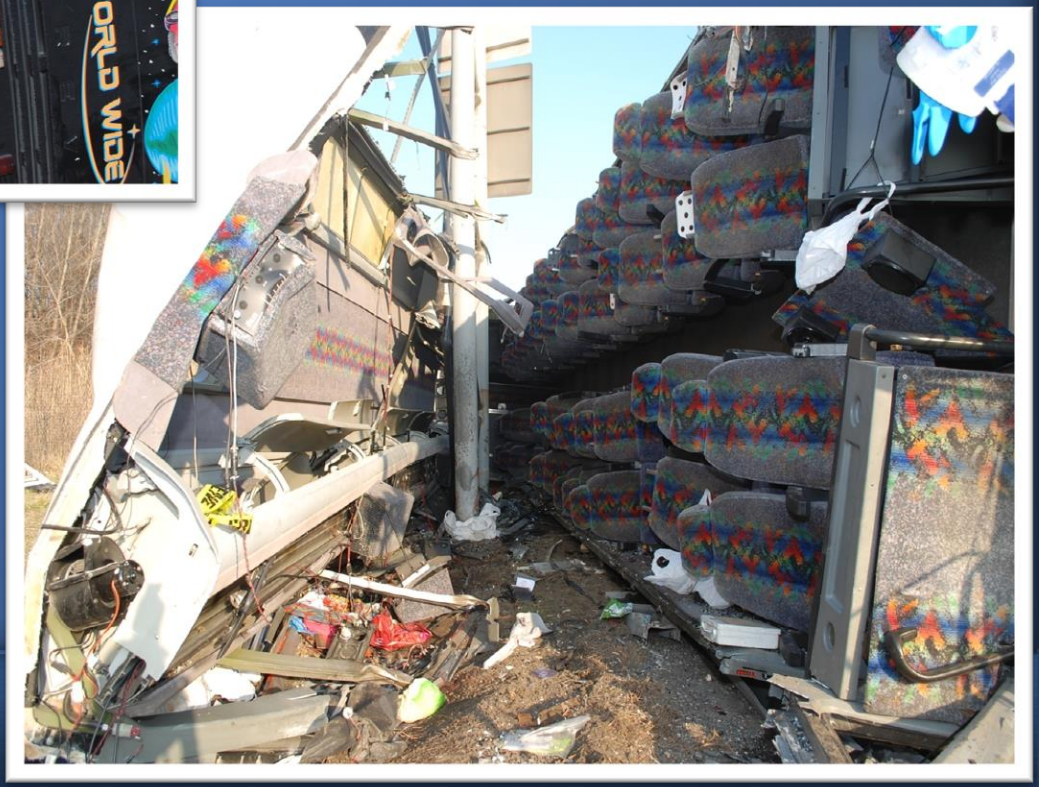
Animation of Accident Reconstruction

Motorcoach Run Off Road-Collision with Bridge Signpost

Interstate Highway 95 Southbound
New York, New York
March 12, 2011

HWY11MH005

‘Bronx Bus’, New York, NY (March 12, 2011)



15 fatalities

17 injuries

Probable Cause

"The National Transportation Safety Board determines that the probable cause of the accident was the motorcoach driver's failure to control the motorcoach due to fatigue resulting from failure to obtain adequate sleep, poor sleep quality, and the time of day at which the accident occurred."

NTSB Safety Recommendations: Fatigue

- 40 years ago: May 10, 1972
- “Revise FAR 135 to provide adequate flight and duty time limitations.” (A-72-55)
- Classified “Closed-Unacceptable”

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Home > Transportation Safety > Most Wanted List

SHARE

MOST WANTED LIST

A program to increase the public's awareness of, and support for, action to adopt safety steps that can help prevent accidents and save lives.
The following are ten of the current issues.

Addressing Human Fatigue

General Aviation Safety

Safety Management Systems

Runway Safety

Bus Occupant Safety

Pilot & Air Traffic Controller Professionalism

Recorders

Teen Driver Safety

Addressing Alcohol-Impaired Driving

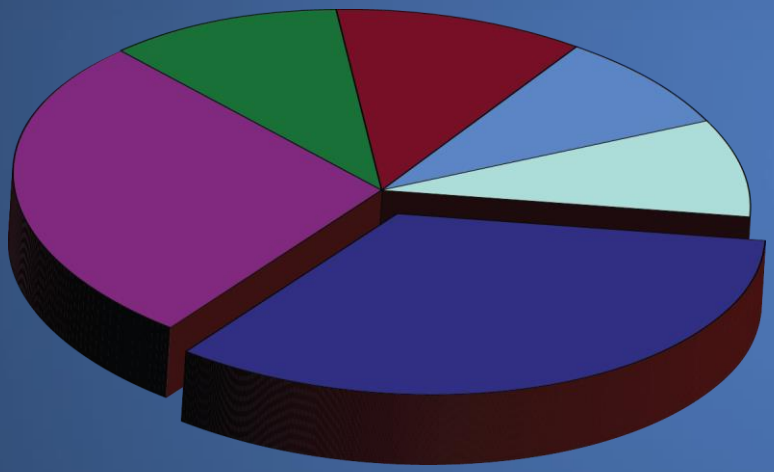
Motorcycle Safety

NTSB

NTSB Recommendations

- MOST WANTED 1990 - 2011
- >200 fatigue recommendations

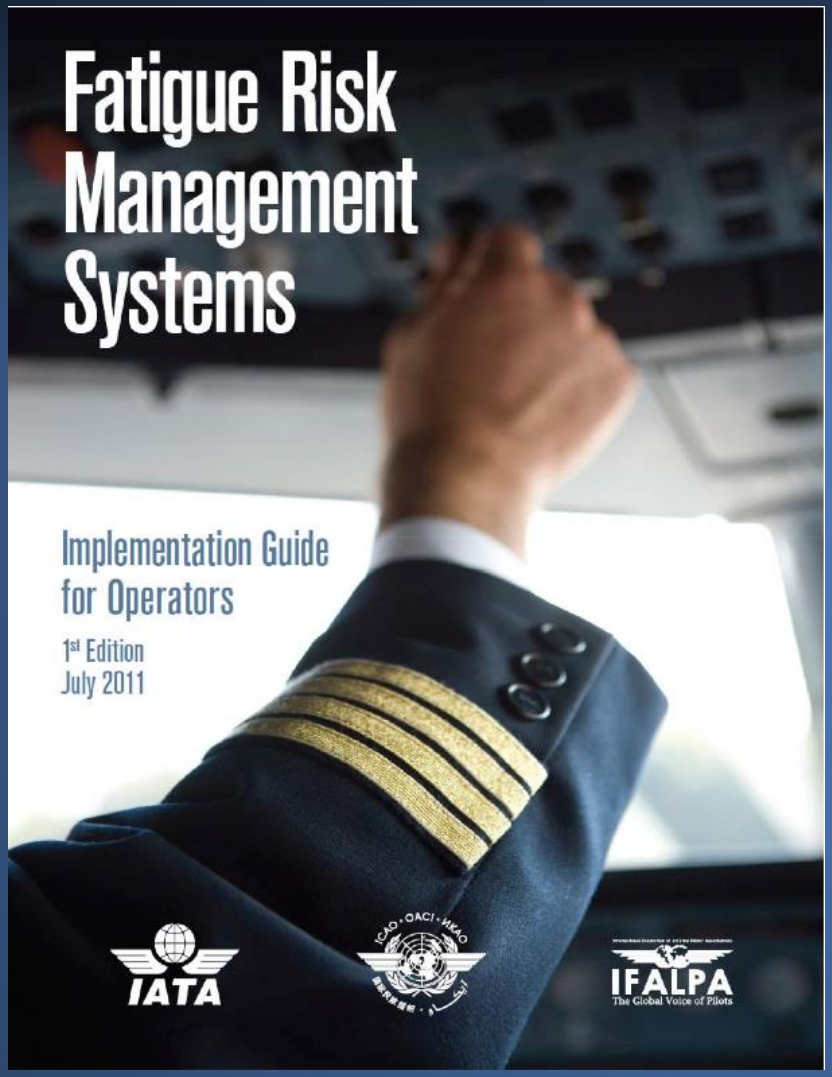
Complex Issue:

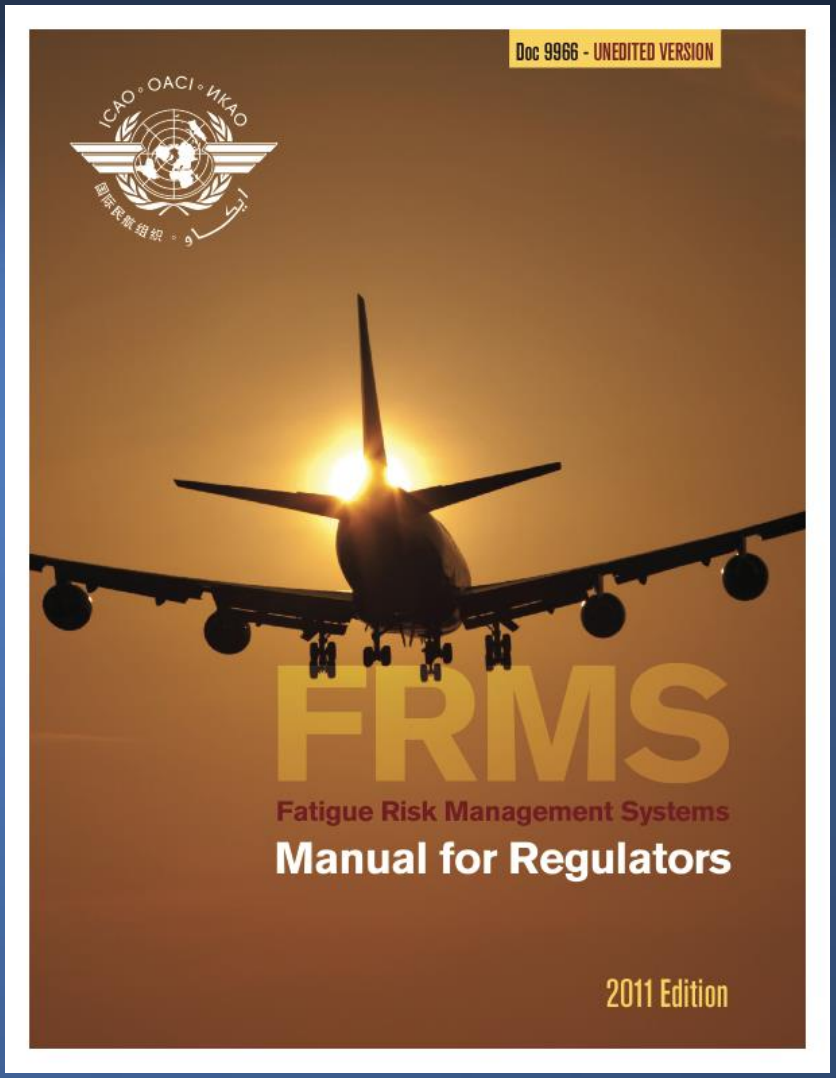


Requires Multiple Solutions

- Scheduling Policies and Practices
- Education/Awareness
- Organizational Strategies
- Healthy Sleep
- Vehicle and Environmental Strategies
- Research and Evaluation

Examples


Fatigue Risk Management Systems
Implementation Guide for Operators
1st Edition
July 2011
IATA
ICAO • OACI • ИКАО
IFALPA
The Global Voice of Pilots


Doc 9966 - UNEDITED VERSION
ICAO • OACI • ИКАО
FRMS
Fatigue Risk Management Systems
Manual for Regulators
2011 Edition

NTSB Safety Recommendations: Fatigue Status (May, 2012)

- Total: 194
- Open: 48
- Closed: 146
- CUN*: 26

CUN = closed unacceptable

NTSB

UPS 1354 (8/14/13)

To the Federal Aviation Administration:

1. Require principal operations inspectors to ensure that operators with flight crews performing 14 *Code of Federal Regulations* Part 121, 135, and 91 subpart K overnight operations brief the threat of fatigue before each departure, particularly those occurring during the window of circadian low. (A-14-XX)

Manage Fatigue = Enhance Safety

- Culture change
- Get educated
- Acknowledge risk
- Take action!

Good sleep, safe travels.

National Transportation Safety Board